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Terra MODIS RSB On-Orbit Calibration and Performance: Four Years of Data

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ABSTRACT

Terra MODIS, also referred to as the MODIS Protoflight Model (PFM), was launched on-board the NASA's EOS Terra spacecraft on December 18, 1999. It has been in operation for more than four years and continuously providing the science community quality data sets for studies of the Earth's land, oceans, and atmosphere. It has also served as the primary source of information for the MODIS Land Rapid Response System for observing and reporting on natural disasters, and providing active fire information around the Earth. The MODIS instrument has 36 spectral bands with wavelengths ranging from 0.41 μ m to 14.5 μ m: 20 bands with wavelengths below 2.2 μ m are the reflective solar bands (RSB) and the other 16 bands are the thermal emissive bands (TEB). The RSB are calibrated on-orbit using a solar diffuser (SD) with the degradation of its bi-directional reflectance factor (BRF) tracked by an on-board solar diffuser stability monitor (SDSM). The calibration coefficients are updated via Look-Up Tables (LUTs) for the Level 1B code that converts the sensor's Earth view response from digital counts to calibrated reflectance and radiance. In this paper we review the MODIS RSB on-orbit calibration algorithm and the methodology of computing and updating the calibration coefficients determined from the SD and SDSM data sets. We present examples of the sensor's long-term and short-term stability trending of key RSB calibration parameters using over four years of on-orbit calibration data sets. Special considerations due to changes in instrument configuration and sensor response are also discussed.

Keywords: MODIS, reflective solar bands, calibration, solar diffuser, solar diffuser stability monitor

1. INTRODUCTION

The MODerate Resolution Imaging Spectroradiometer (MODIS), one of the key instruments of the NASA Earth Observing System (EOS), is currently operating on both the Terra and Aqua satellites launched on December 18 1999 and May 4 2002 respectively¹⁻³. The instrument is capable of observing the entire Earth in approximately two days via 36 spectral bands with wavelengths ranging from 0.41 μ m to 14.5 μ m and nadir instantaneous fields of view (IFOV) of 250m, 500m and 1km. Its design and development are extensions of other space-borne sensors such as the Advanced Very High Resolution Radiometer (AVHRR), the Nimbus-7 Coastal Zone Color Scanner (CZCS), the Landsat Thematic Mapper (TM), and the CZCS/SeaWiFS series. The two MODIS instruments provide continuous and complementary observations of the Earth with Terra orbiting in a near Sun-synchronous polar orbit of 10:30 AM local equator crossing time and Aqua in an orbit of 1:30 PM local equator crossing time. Each sensor views the Earth over a $\pm 55^\circ$ range of scan angles about instrument nadir, producing a swath 10 km (at nadir) along track and 2330 km cross-track each 1.478 second scan.

The twenty MODIS spectral bands with wavelengths below 2.2 μ m are the reflective solar bands (RSB) and the other 16 bands are the thermal emissive bands (TEB). The RSB are calibrated on-orbit using a solar diffuser (SD) with the degradation of its bi-directional reflectance factor (BRF) tracked via a on-board solar diffuser stability monitor (SDSM).